NOVEMBER 2019

WIM #34
MN 23, MP 122.1
CLARA CITY, MN

MONTHLY REPORT

Your Destination...Our Priority

WIM Site Location

WIM #34 is located on MN 23 near Clara City in Chippewa county.

System Operation

WIM #34 was operational for the entire month of November 2019. Volume was computed using all monthly data.

System Calibration

WIM #34 was most recently calibrated on 2019-05-16. Table 1 summarizes the front axle weights of class 9s by lane [1]. Figure 1 shows the distribution of gross vehicle weights (GVW) in Class 9 vehicles at this site for the last 12 months of operation [2]. Figure 2 depicts the average front axle weight as a percent difference from the first full month following calibration.

Summary of Volume Statistics

Total Monthly Volume: 96351 | Passenger Vehicles: 81537 | Heavy Commercial Vehicles: 14814

Monthly Average Daily Traffic (MADT): 3263 | Monthly Heavy Commercial Average Daily Traffic (MHCADT): 494

See Table 2 for vehicle class breakdown

Passenger Vehicles (PVs) and Heavy Commercial Vehicles (HCVs)

Volume trends. NB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Wednesdays. SB vehicles typically reached highest volume levels on Fridays, with lowest volumes reported on Wednesdays (see Figure 3 and 4).

Passenger Vehicles (PVs)

Volume trends. On an average 24-hour day (see Figure 5), NB PVs generally reached peak volume levels between 03 PM and 05 PM. Similarly, SB PVs peaked in volume between 03 PM and 05 PM

Heavy Commercial Vehicles (HCVs)

Volume trends. On an average 24-hour day, HCVs traveling NB typically reached peak volume levels between 03 PM and 05 PM, while volume going SB peaked between 03 PM and 05 PM. See Figure 6. Out of all HCVs, the two highest traffic volumes were generated by Class 9's and Class 5's.

Overweight HCVs

Volume trends. Of a total of 14814 HCVs, 1361 of them were overweight [3]. These overweight HCVs contributed to 1.4% of total monthly volume, and 9.3% of total monthly

HCV volume. NB overweight vehicles typically reached highest numbers on Mondays, with lowest volumes reported on Sundays. SB overweight vehicles tended to reach highest volumes on Mondays, with lowest volumes reported on Sundays. See Figure 3 .
The top two overweight violators by class were the class 9 and class 13 vehicles . Overall, overweight vehicles tended to reach peak volume concentrations during typical business hours, with 51.2% of all overweight vehicles traveling SB this month (see Figure 7 & 8). Figure 9 shows the number of vehicles exceeding 88,000 pounds that crossed the WIM over the last 12 months. The highest number of 88,000+ vehicles within the last 12 months occurred in June.
WIMs are currently used as a screening tool for weight enforcement, and it is estimated that the WIM scales can measure gross vehicle weights (GVW) within 90-95% of static weight scale measurements. Due to the possibility of measurement error, vehicles exceeding 10% of their legal weight limits (or 1.1 times their legal weight limits) are considered overweight in this report [4].
Using normal load limits ,111 NB vehicles exceeded 88,000 pounds (80 vehicles were Class 13's; 25 vehicles were Class 10's). Of vehicles traveling SB,

71 NB vehicles exceeded 88,000 pounds (49 vehicles were Class 13's; 14 vehicles were Class 10's). Refer to Table 3 for the Top 10 highest recorded GVWs from Classes 9 and 10 from November 2019.

Loaded vs. Unloaded HCVs. Figure 10 shows the GVW distributions of Class 9s and 10s in November 2019. Data suggests that there were greater numbers of fully_loaded Class 9's than empty Class 9's traveling NB, while there were more fully_loaded Class 9's than empty traveling SB. Data also suggests that there were more fully_loaded Class 10's than empty traveling in the NB direction. In the SB direction, there were more fully_loaded class 10 vehicles.

Freight Totals. A total of 112291 tons of freight was recorded to have crossed the WIM. More freight was shipped SB (56.5%) than NB (43.5%). See Table 4 and Figure 11 for more freight information.

####**Infrastructure Considerations Bridge.** Bridge No. 12012 is approximately 3.8 miles north of WIM #34, and Bridge No. 12004 is 3.1 miles south of WIM #34. WIM #34 recorded a total of 96351 vehicles with a combined GVW of 990391 kips (1 kip = 1,000 pounds = 0.5 tons) in November 2019. See Table 5 and Figures 12-13 for GVW information by vehicle class and lane.

Pavement Design. A total of 9491 equivalent single axle loads (ESALs) passed over the pavement at this site. Approximately 56% of all ESALs were recorded SB while 44% was observed NB. In particular, 73% of all ESALs were generated by the Class 9's (Class 9's were also responsible for generating 44% of total GVW observed this month). See Table 6 and Figures 14-15 for more information on ESALs (Table 6 also provides flexible ESAL factors for each vehicle class using a terminal serviceability of 2.5 and a structural number of 5).

#####WIM monthly reports can be found at:
http://www.dot.state.mn.us/traffic/data/reports-monthly-wim.html MnDOT's vehicle

classification scheme and vehicle class groupings for traffic forecasting can be found at: http://www.dot.state.mn.us/traffic/data/data-products.html#weight

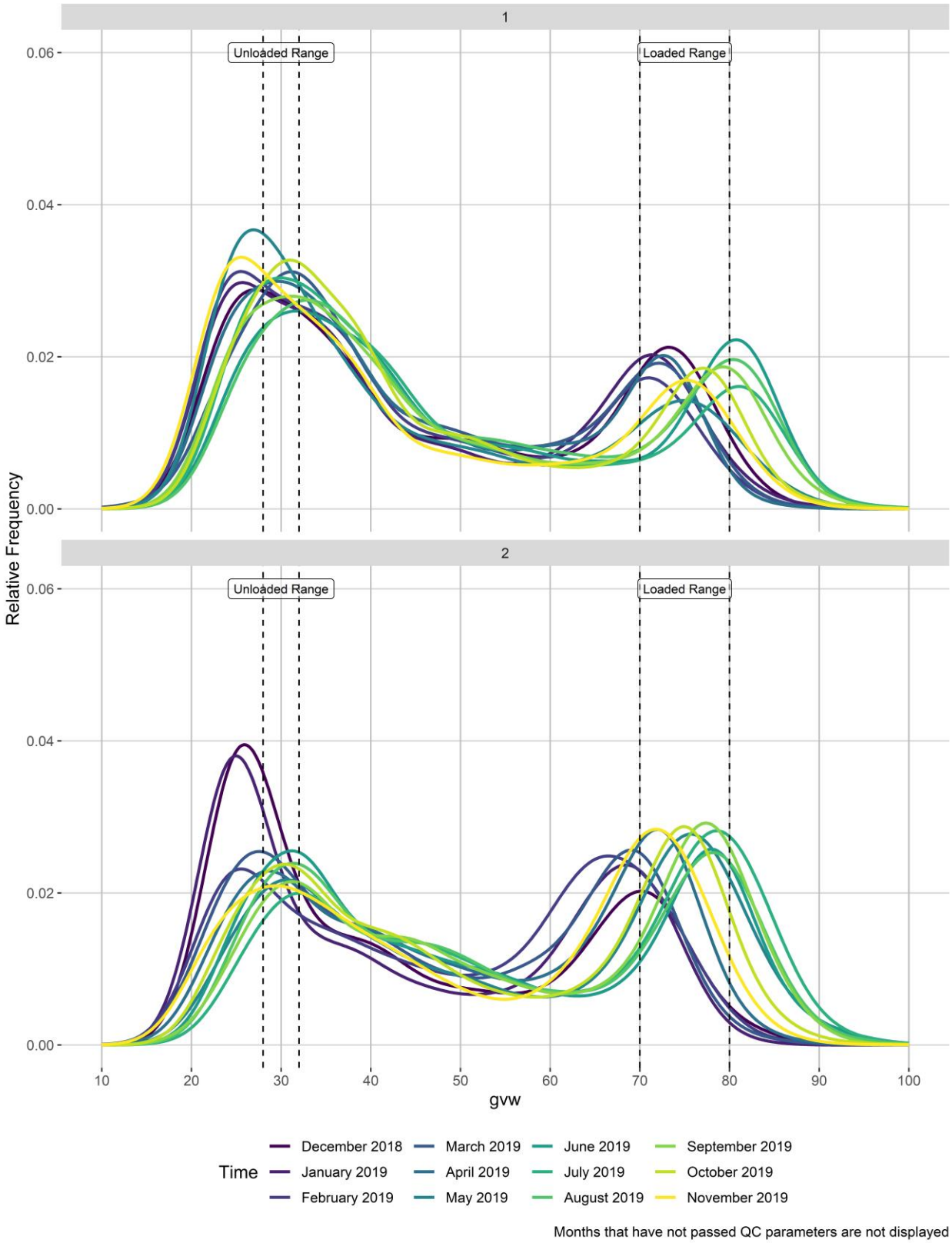
- [1] Front axle weights of Class 9s are monitored on a monthly basis to assure performance between calibrations. The current goal of the WIM scale calibration is to have each individual axle weight stay within a range of ?9% of baseline calibration values

- [2] Previous WIM research indicates that unloaded Class 9s typically weigh 28-32 kips, while loaded Class 9s generally fall in the 70-80 kip range. More recent data from several WIM sites suggests that the unloaded Class 9 range may have moved a little higher over time (due to increased presence of sleeper cabs, etc.), although these ranges are also thought to be site-specific.

- [3] An HCV is considered overweight during normal load limits in this report if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 80,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 20,000 pounds; tandem axles spaced 8' or less = 34,000 pounds; tridem axles spaced 9' or less = 43,000 pounds; quad axles spaced 13' or less = 51,000 pounds). Monthly reports use this standard regardless of the time of year however, the Winter Load Increase (WLI) allows a 10% across the board increase in axle and gross vehicle weights without a permit on US, state routes, and county roads. An HCV is considered overweight during Winter Load Increase(WLI) if they satisfy any of the following 1) exceed a gross vehicle weight (GVW) of 88,000 pounds, 2) exceed any of the legal weight maximums on any axle configurations (legal maximums are: single axle = 22,000 pounds; tandem axles spaced 8' or less = 37,400 pounds; tridem axles spaced 9' or less = 47,300 pounds; quad axles spaced 13' or less = 56,100 pounds). An overweight HCV is only included once in the overweight volume calculations regardless of how many of the aforementioned conditions are violated. For information on MN weight limit dates and statutes: http://www.mrr.dot.state.mn.us/research/seasonal_load_limits/sllindex.asp

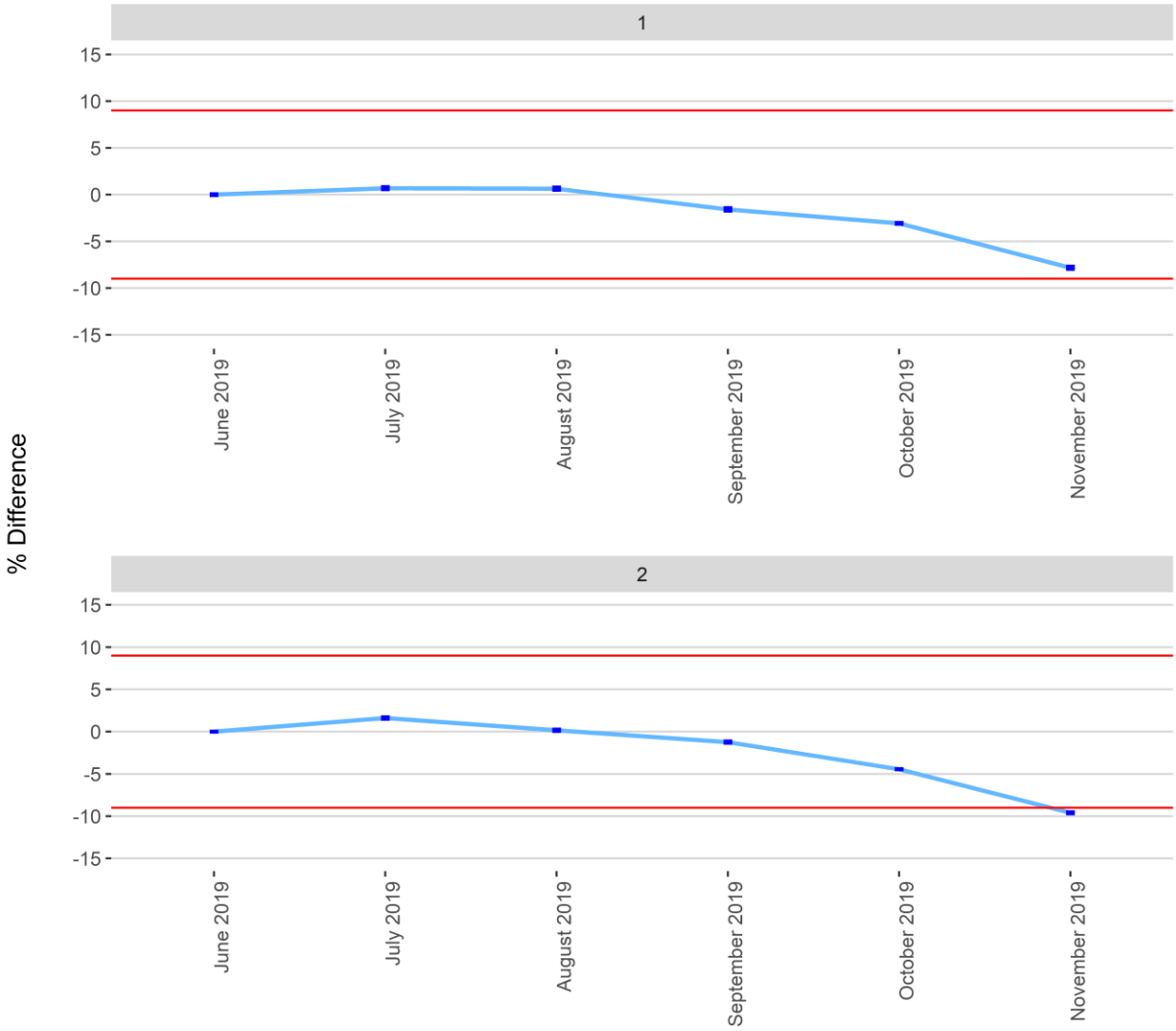
- [4] For example, Class 9s and 10s can legally have gross vehicle weights up to 80,000 lbs (with the exception of permitted loads) during normal load limits. To account for measurement error on the WIM scales, those exceeding 10% of the legal GVW maximum (or 1.1 times the legal GVW) should be screened (e.g., 80,000 lbs + 8,000 lbs = 88,000 lbs). Similarly during WLI vehicles weighing 96,800 lbs should be screened.

Figure 1 - Monthly Class 9 GVW Histogram



Months that have not passed QC parameters are not displayed

Figure 2 - Percent Difference of Front Axle Weight from Last Calibration (+/- 95% CI)



Months that have not passed QC parameters are not displayed

Figure 2 - Average Vehicle Volume vs. Day of the Week

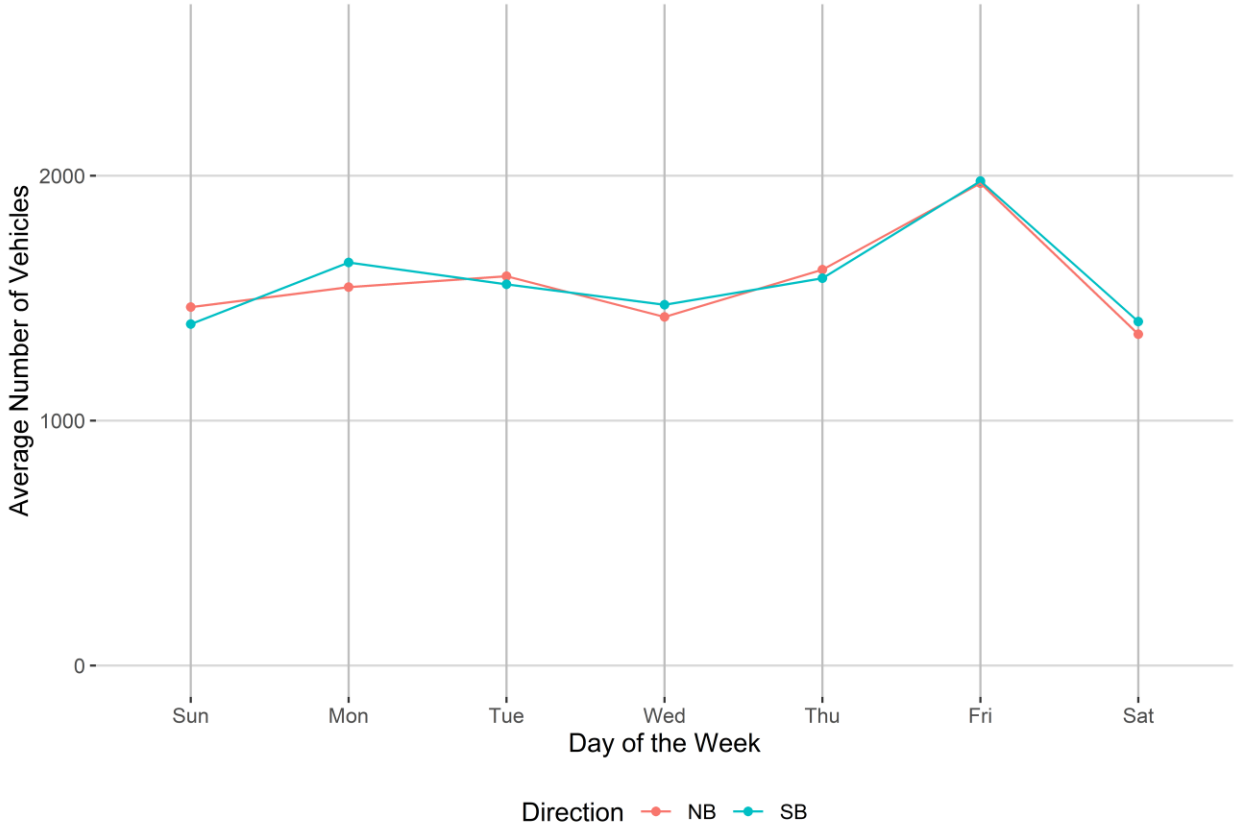


Figure 3 - Average Overweight Vehicle Volume vs. Day of the Week

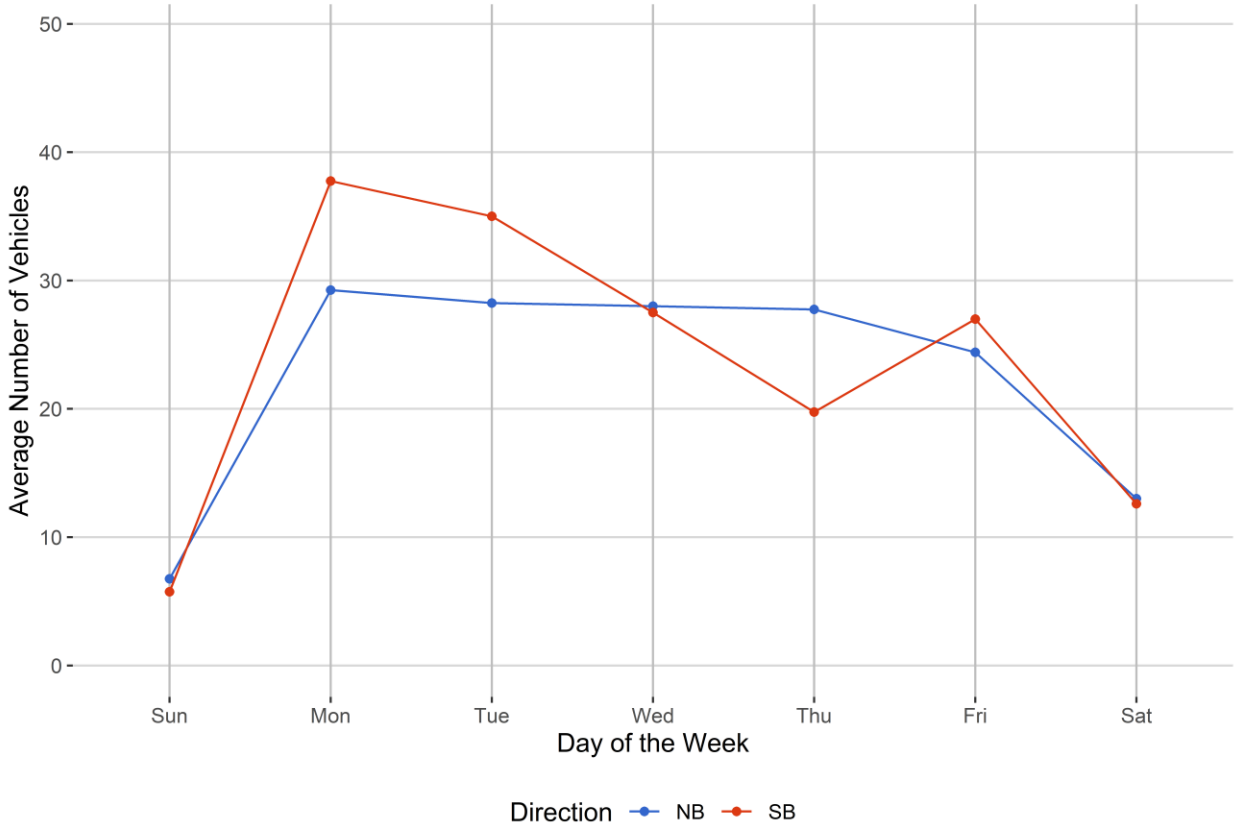


Figure 4 - Passenger Vehicles
vs. Hour of the Day

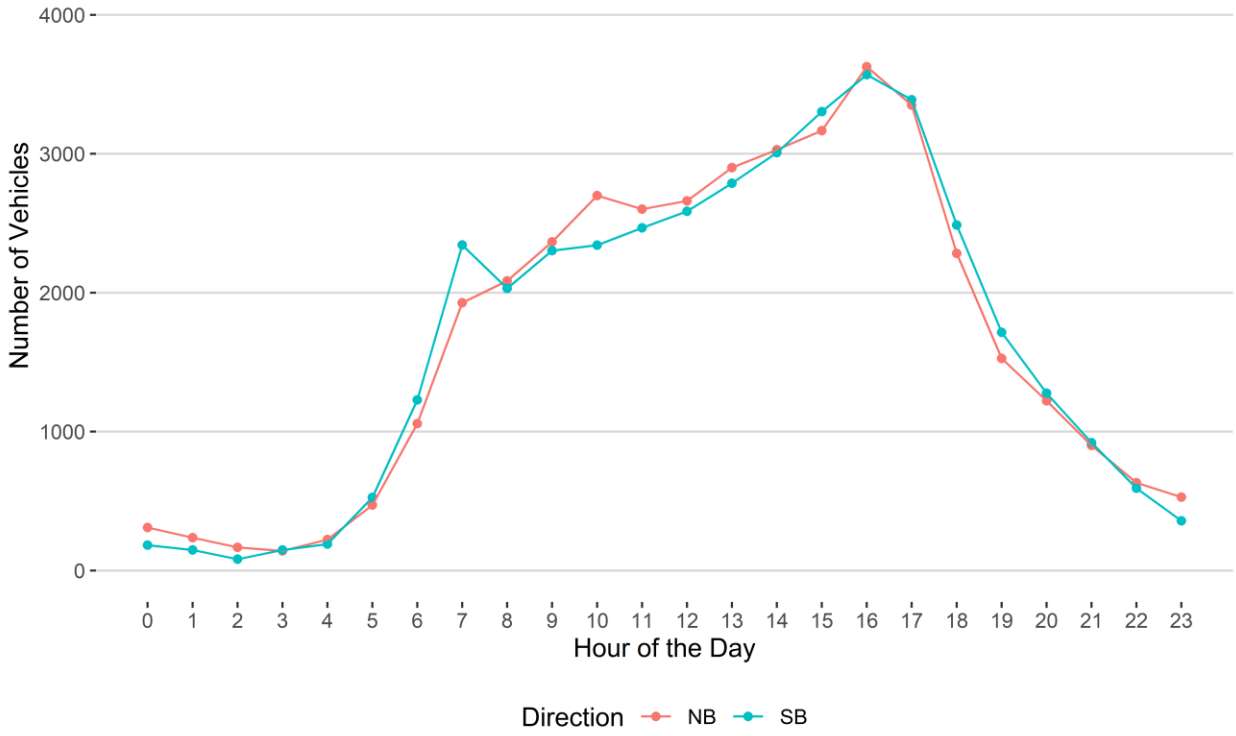


Figure 5 - Heavy Commercial Vehicles
vs. Hour of the Day

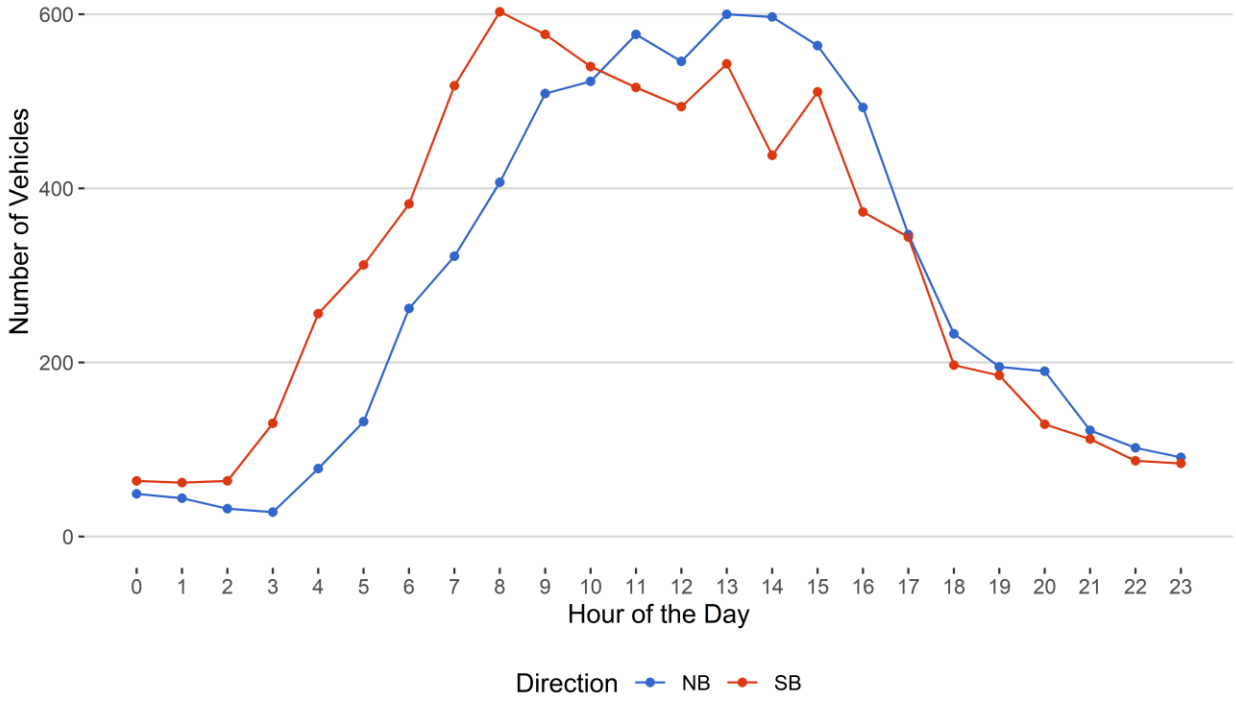


Figure 6 - Overweight Vehicles by Class vs. Hour of the Day

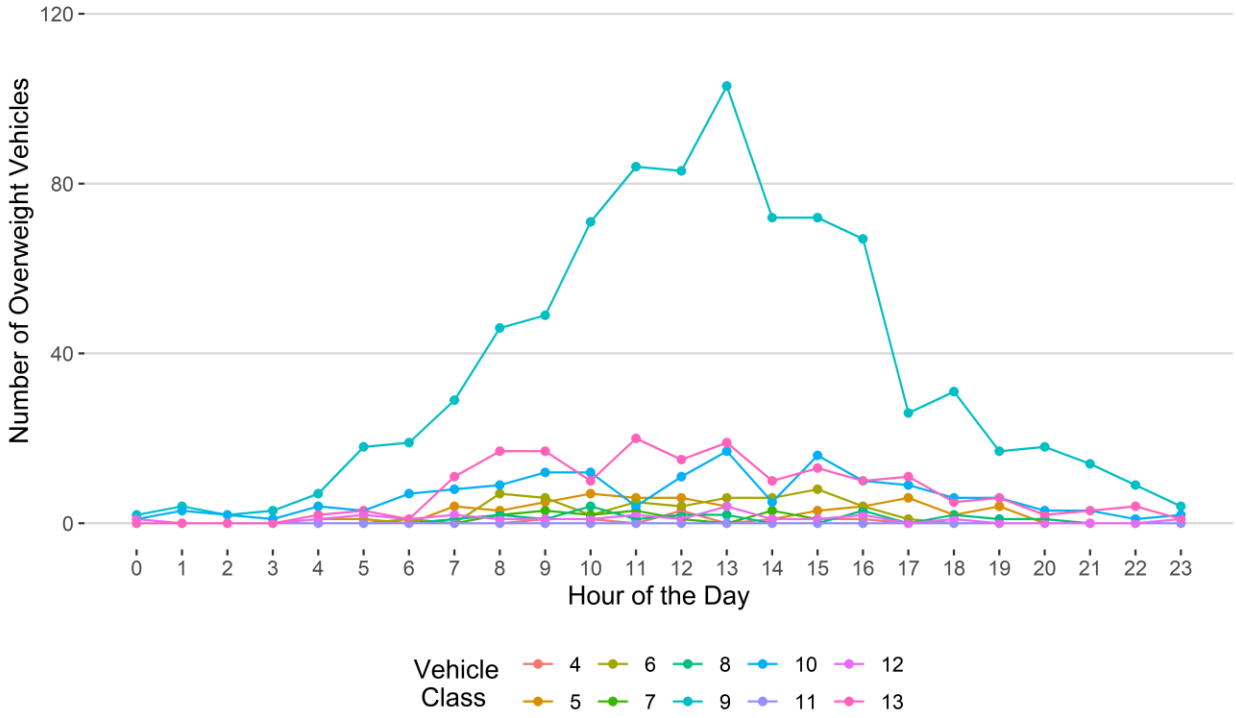


Figure 7 - Overweight Vehicles by Direction
Hour of the Day

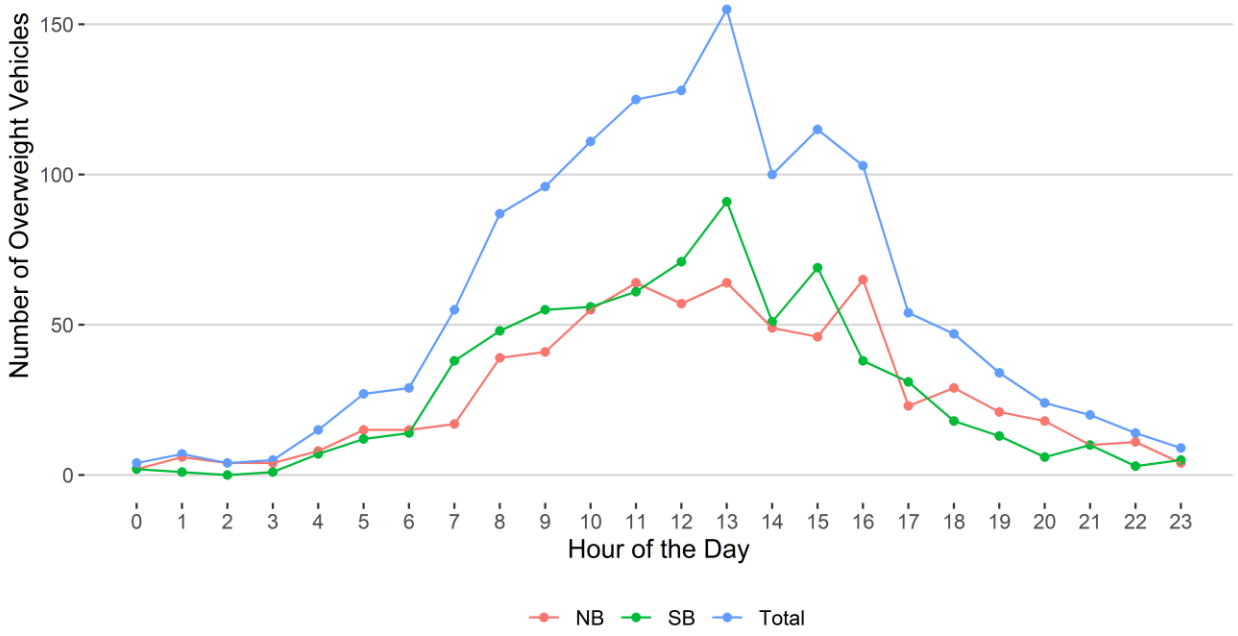
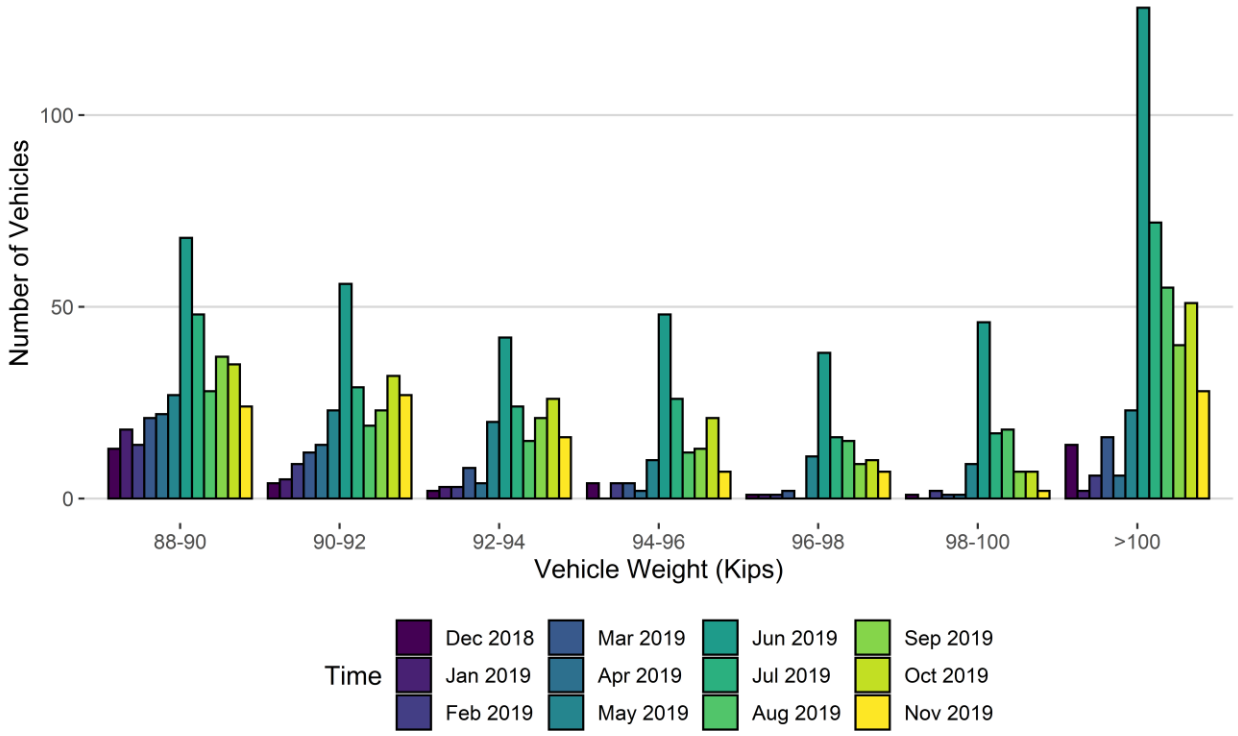
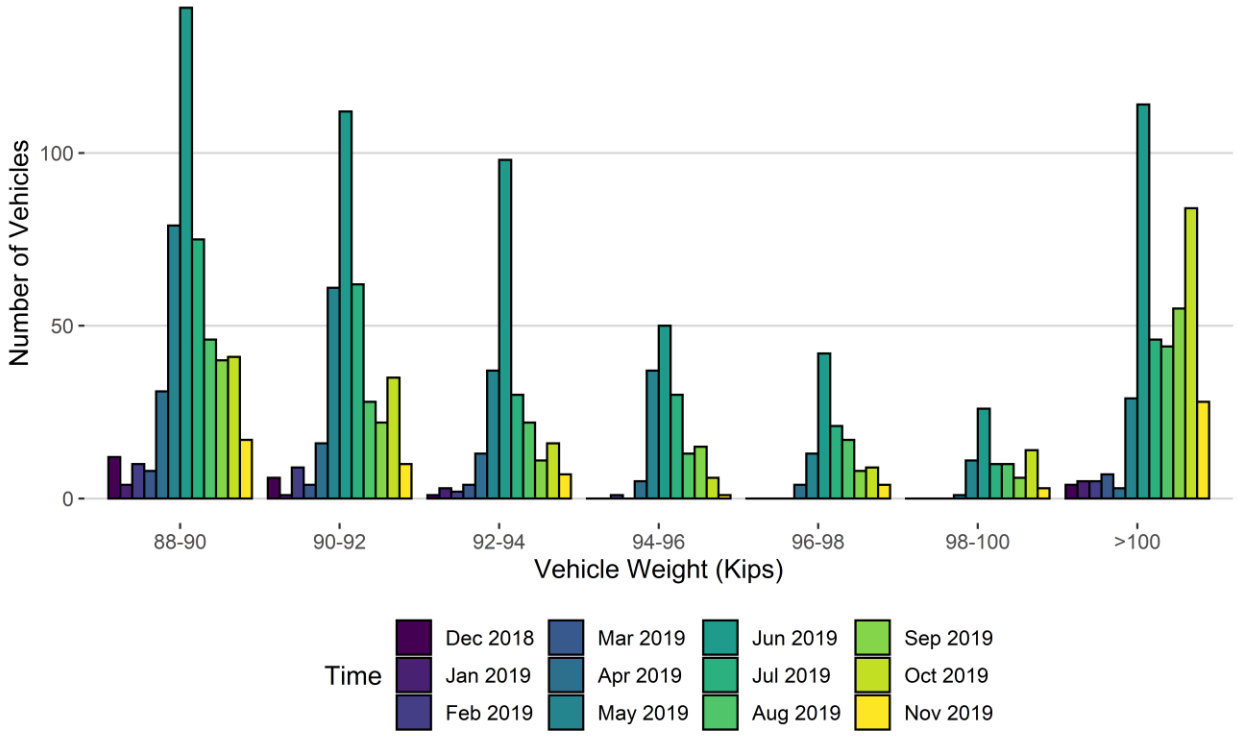


Figure 8 - Histogram of NB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	*Dec 2018*	*Jan 2019*	*Feb 2019*	*Mar 2019*	*Apr 2019*	*May 2019*	*Jun 2019*	*Jul 2019*	*Aug 2019*	*Sep 2019*	*Oct 2019*	*Nov 2019*
88-90	13	18	14	21	22	27	68	48	28	37	35	24
90-92	4	5	9	12	14	23	56	29	19	23	32	27
92-94	2	3	3	8	4	20	42	24	15	21	26	16
94-96	4	0	4	4	2	10	48	26	12	13	21	7
96-98	1	1	1	2	0	11	38	16	15	9	10	7
98-100	1	0	2	1	1	9	46	17	18	7	7	2
>100	14	2	6	16	6	23	128	72	55	40	51	28
Total	39	29	39	64	49	123	426	232	162	150	182	111

Figure 8 - Histogram of SB Vehicles Over 88,000 Pounds for Current Month



Vehicle Weights (Kips)	*Dec 2018*	*Jan 2019*	*Feb 2019*	*Mar 2019*	*Apr 2019*	*May 2019*	*Jun 2019*	*Jul 2019*	*Aug 2019*	*Sep 2019*	*Oct 2019*	*Nov 2019*
88-90	12	4	10	8	31	79	142	75	46	40	41	17
90-92	6	1	9	4	16	61	112	62	28	22	35	10
92-94	1	3	2	4	13	37	98	30	22	11	16	7
94-96	0	0	1	0	5	37	50	30	13	15	6	1
96-98	0	0	0	0	4	13	42	21	17	8	9	4
98-100	0	0	0	0	1	11	26	10	10	6	14	3
>100	4	5	5	7	3	29	114	46	44	55	84	28
Total	23	13	27	23	73	267	584	274	180	157	205	70

Figure 8 - Class 9's and 10's by Direction vs Gross Vehicle Weight

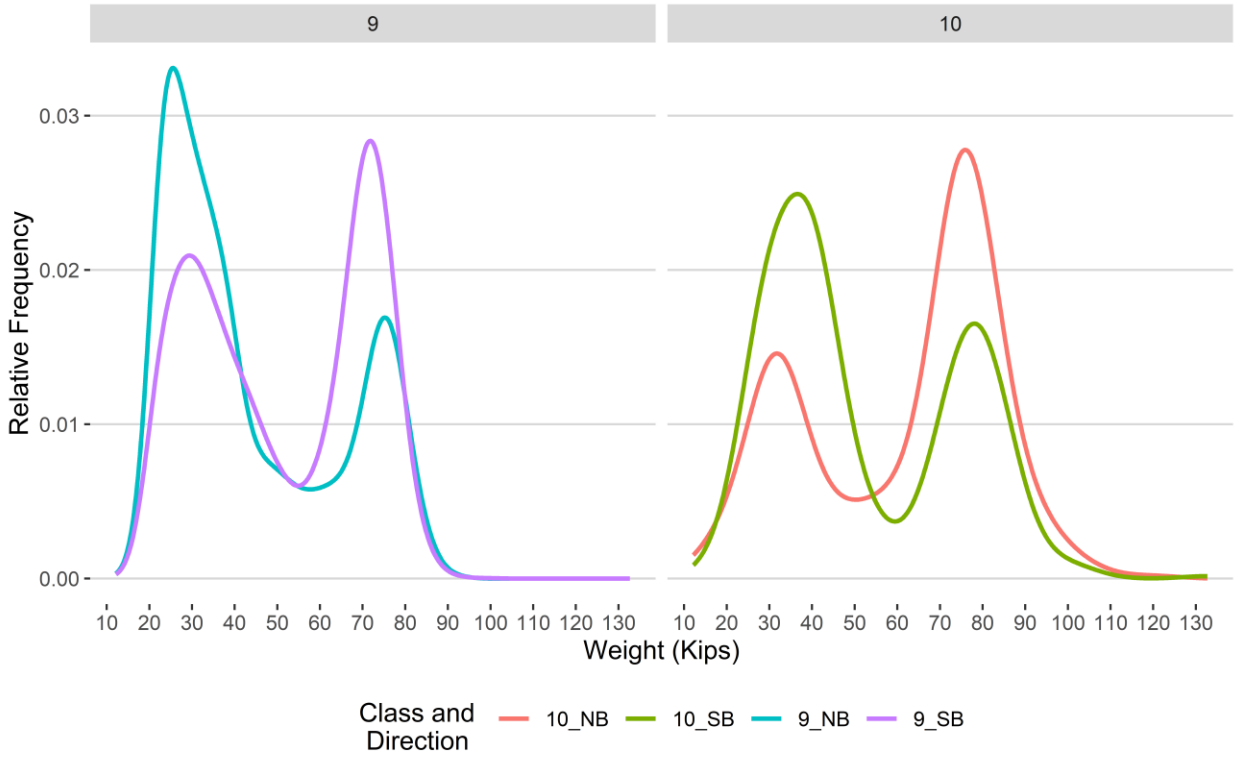


Figure 9 - Freight Percentage by Direction and Class

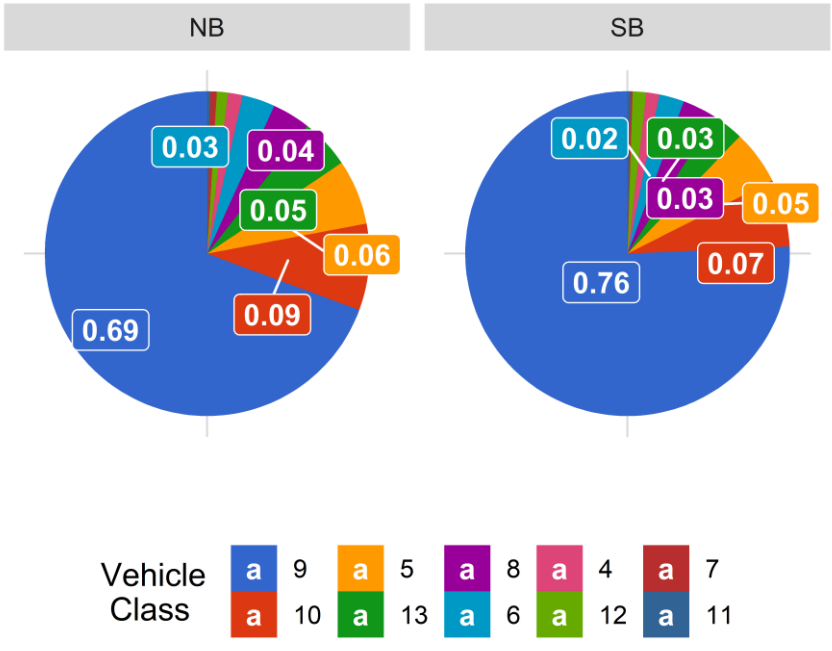


Figure 10 - Total Gross Vehicle Weight Percentage by Class and Lane

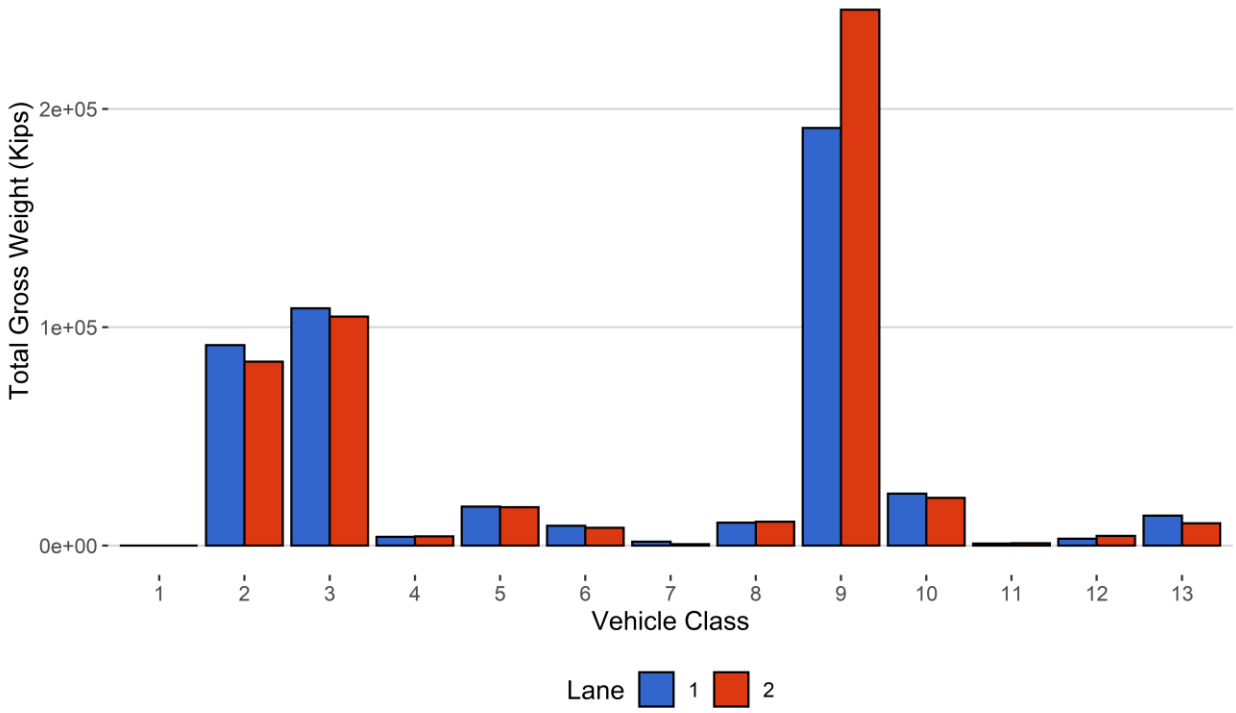
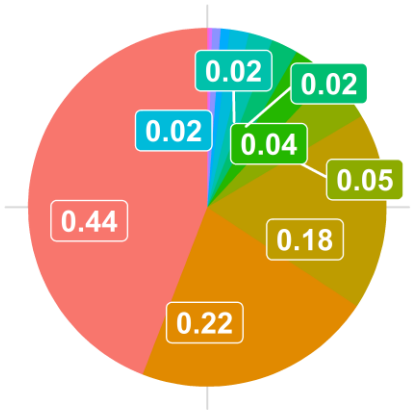


Figure 11 - Total Gross Vehicle Weight b



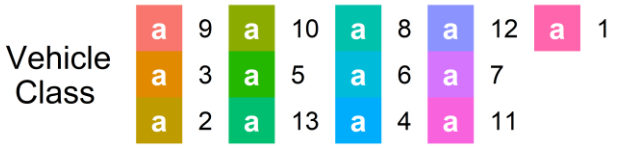


Figure 12 - Total ESALs by Class and Lane

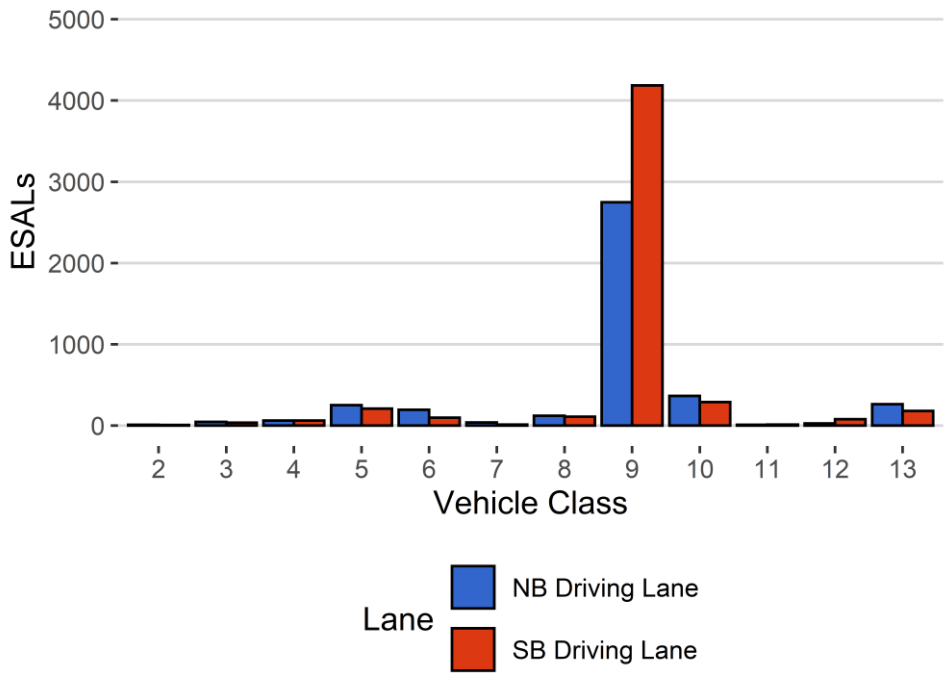


Figure 13 - ESALs by Class

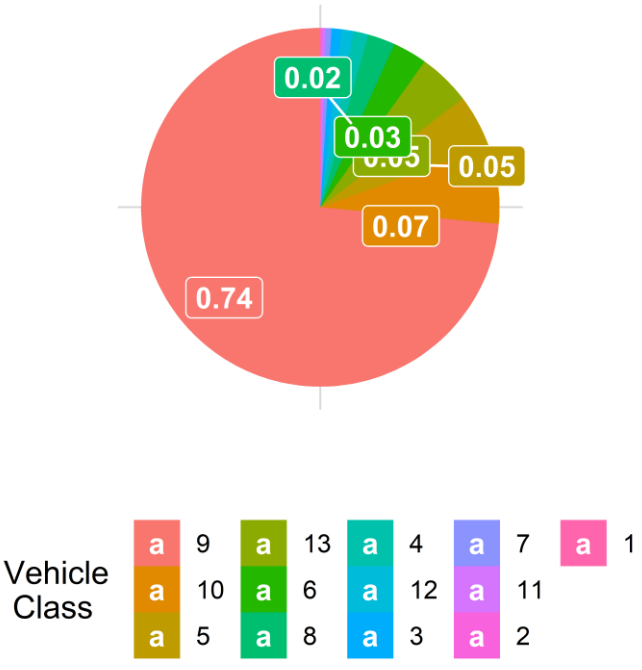


Table 1 Class 9 Front Axle Weight by Lane

Month	*Lane 1 (Kips)*	*Front Axle +/- 9%*	*Lane 2 (Kips)*	*Front Axle +/- 9%*
June 2019	11.02	0.00	11.18	0.00
July 2019	11.10	0.69	11.36	1.61
August 2019	11.09	0.64	11.19	0.17
September 2019	10.85	-1.58	11.04	-1.24
October 2019	10.68	-3.08	10.68	-4.45
November 2019	10.16	-7.83	10.10	-9.59

Table 2 Vehicle Classification Data

Vehicle Class	*Monthly Average Daily Volume*	*Monthly Total Volume*	*Monthly Total Volume Percentage*	*Monthly Total Overweight Vehicles*	*Monthly Total Overweight Percentage*
1	0	2	0	0	0
2	1540	46195	47.9	0	0
3	1178	35339	36.7	0	0
4	10	289	0.3	8	0.6
5	88	2626	2.7	58	4.3
6	20	609	0.6	50	3.7
7	1	42	0	17	1.2
8	25	743	0.8	20	1.5
9	308	9252	9.6	850	62.5
10	27	817	0.8	155	11.4
11	1	43	0	0	0
12	4	125	0.1	23	1.7
13	9	269	0.3	180	13.2
TOTAL	**3212**	**96351**	**100**	**1361**	**100**

Table 3 Top 10 Gross Vehicle Weight, Class 9 and 10

Date	*Day of Week*	*Time*	*Vehicle Class*	*Direction*	*Lane*	*GVW (lbs)*
2019-11-04	Monday	15:31:35	10	SB	2	132.7
2019-11-14	Thursday	14:35:24	10	NB	1	120.32
2019-11-09	Saturday	16:14:08	10	NB	1	108.54
2019-11-05	Tuesday	11:46:38	10	NB	1	105.93
2019-11-12	Tuesday	09:54:02	10	NB	1	104.69
2019-11-11	Monday	07:06:01	10	SB	2	104.28
2019-11-07	Thursday	05:14:03	10	NB	1	104.07
2019-11-12	Tuesday	13:33:56	10	SB	2	102.81
2019-11-13	Wednesday	21:32:45	10	NB	1	101.81
2019-11-05	Tuesday	10:43:29	10	SB	2	100.9

Table 4 Freight Summary

Vehicle Class	*Direction*	*Weight of Empty Vehicle (Kips)*	*Total Number of Vehicles*	*Number of Empty Vehicles*	*Percentage of Empty Vehicles*	*Total Weight of Vehicles with Freight (Kips)*	*Total Weight of Empty Vehicles (Kips)*	*Total Weight of Freight (Tons)*
4	NB	15	132	26	19.7	3650	326	1030
5	NB	8	1282	151	11.8	16755	1105	3853
6	NB	19	285	56	19.6	8056	951	1852
7	NB	11.5	30	0	0	1758	0	706
8	NB	31	361	222	61.5	5236	5246	463
9	NB	33	4332	1833	42.3	143184	48036	30359
10	NB	33.5	384	83	21.6	21385	2364	5651
11	NB	36.5	20	3	15	761	104	70
12	NB	36.5	64	4	6.2	3012	113	411
13	NB	31.5	153	0	0	13659	0	4420
TOTAL	****	****	**7043**	**2378**	****	**217455**	****	**48816**
Vehicle Class	Direction	Weight of Empty Vehicle (Kips)	Total Number of Vehicles	Number of Empty Vehicles	Percentage of Empty Vehicles	Total Weight of Vehicles with Freight (Kips)	Total Weight of Empty Vehicles (Kips)	Total Weight of Freight (Tons)
4	SB	15	152	30	19.7	3835	378	1002
5	SB	8	1300	249	19.2	15729	1805	3660
6	SB	19	314	102	32.5	6388	1703	1180
7	SB	11.5	11	0	0	608	0	241
8	SB	31	369	199	53.9	6229	4695	480
9	SB	33	4764	1286	27	211133	34275	48180
10	SB	33.5	419	107	25.5	18781	3067	4164
11	SB	36.5	22	2	9.1	973	45	122
12	SB	36.5	59	0	0	4388	0	1117
13	SB	31.5	111	1	0.9	10124	30	3330
TOTAL	****	****	**7521**	**1976**	****	**278188**	****	**63476**
GRAND TOTAL	****	****	**14564**	**4354**	**386**	**495643**	**104245**	**112291**

Table 5 Gross Vehicle Weight by Class and Lane

Vehicle Class	*NB*	*SB*	*Total*	*Percentage*
1	1	1	3	0
2	91785	84244	176029	17.8
3	108680	104887	213567	21.6
4	3976	4213	8189	0.8
5	17860	17534	35394	3.6
6	9007	8091	17099	1.7
7	1758	608	2365	0.2
8	10482	10924	21406	2.2
9	191220	245409	436628	44.1
10	23749	21848	45597	4.6
11	865	1018	1883	0.2
12	3125	4388	7513	0.8
13	13659	10154	23813	2.4
TOTAL	**476166**	**513320**	**989486**	**100**
GVW/LANE	**48.12**	**51.88**	**100**	**0.01**

Table 6 ESALs by Class and Lane and Flexible ESAL Factors

Vehicle Class	*NB*	*SB*	*Total*	*Percentage*	*Flexible ESAL Factor*
1	0	0	0	0	0.3333
2	11	9	20	0.2	9e-04
3	46	37	84	0.9	0.0049
4	62	62	125	1.3	0.88
5	253	210	463	4.9	0.36
6	196	98	293	3.1	0.99
7	38	13	51	0.5	2.28
8	122	110	232	2.5	0.64
9	2748	4185	6933	73.5	1.53
10	365	289	654	6.9	1.63
11	10	13	23	0.2	1.09
12	27	79	106	1.1	1.66
13	264	180	444	4.7	3.27
TOTAL	**4142**	**5285**	**9427**	**100**	**15**
ESALS/LANE	**43.9**	**56.1**	**100**	**–**	**–**

Table 7 Site Summary: Volume and Vehicle Class

Month	*Total Volume*	*Monthly ADT*	*Monthly HCADT*	*Passenger Vehicles*	*Passenger Vehicles %*	*Heavy Commercial Vehicles*	*Heavy Commercial Vehicles %*
Dec 2018	89419	2884	461	75130	84	14289	16
Jan 2019	82665	2667	496	67282	81.4	15383.3	18.6
Feb 2019	69157	2470	423	57312	82.9	11844.7	17.1
Mar 2019	88959	2870	393	76774	86.3	12184.6	13.7
Apr 2019	93990	3133	460	80204	85.3	13785.9	14.7
May 2019	114550	3636	595	96108	83.9	18442.1	16.1
Jun 2019	112977	3766	550	96463	85.4	16514	14.6
Jul 2019	117623	3815	556	100380	85.3	17243.1	14.7
Aug 2019	122829	3935	551	105743	86.1	17085.9	13.9
Sep 2019	111609	3740	547	95187	85.3	16422.2	14.7
Oct 2019	111240	3594	544	94374	84.8	16865.8	15.2
Nov 2019	96351	3263	494	81537	84.6	14814.5	15.4
TOTAL	**1211369**	**–**	**–**	**1026494**	**–**	**184875**	**–**
AVERAGE	**100947**	**3314**	**506**	**85541**	**85**	**15406**	**15**

###ESALs

Month	*ESALS NB Driving Lane*	*ESALS SB Driving Lane*	*Total ESALS*	*Pavement Life Decrease Months*
Dec 2018	4765	3913	8678	0.9
Jan 2019	4624	5069	9694	0.5
Feb 2019	3033	3535	6568	1.1
Mar 2019	3076	3597	6674	1.4
Apr 2019	3287	4734	8021	3.5
May 2019	5574	8427	14001	11.1
Jun 2019	15188	14413	29601	9.3
Jul 2019	6532	8499	15031	12.1
Aug 2019	7374	7666	15040	9.4
Sep 2019	5759	7533	13292	6.6
Oct 2019	7588	9522	17109	5.6
Nov 2019	4179	5312	9491	2.6
TOTAL	**70979**	**–**	**–**	**–**
AVERAGE	**5915**	**6852**	**12767**	**5**

###Gross Vehicle Weight

Month	*GVW NB Driving Lane*	*GVW SB Driving Lane*	*Total GVW Kips*
Dec 18	495872	461558	957430
Jan 19	473918	463320	937238

Feb 19	358035	373880	731916
Mar 19	406564	415689	822254
Apr 19	442890	492577	935467
May 19	590185	669683	1259868
Jun 19	1226663	1231162	2457825
Jul 19	622251	671633	1293884
Aug 19	639515	653216	1292731
Sep 19	575436	622627	1198063
Oct 19	820772	879025	1699797
Nov 19	476509	513882	990391
TOTAL	**7128613**	**7448251**	**14576864**
AVERAGE	**594051**	**620688**	**1214739**

###Overweight Vehicles

Month	*Total Number of Overweight Vehicles*	*Overweight / Total Volume*	*Overweight / Heavy Commercial Volume*	*Number Over 88,000 lbs*	*Number Over 98,000 lbs*
Dec 2018	880	1	6.2	62	19
Jan 2019	724	0.9	4.8	44	8
Feb 2019	613	0.9	5.3	67	14
Mar 2019	509	0.6	4.2	87	24
Apr 2019	661	0.7	4.9	122	11
May 2019	2320	2.1	12.7	393	73
Jun 2019	5748	2.6	17.6	1016	320
Jul 2019	3049	2.6	17.9	506	145
Aug 2019	2670	2.2	15.8	344	129
Sep 2019	2395	2.2	14.7	309	110
Oct 2019	2543	1.6	10.5	389	158
Nov 2019	1368	1.4	9.4	182	61
TOTAL	**23480**	**–**	**–**	**3521**	**1072**
AVERAGE	**1956.7**	**1.6**	**10.3**	**293.4**	**89.3**

###Freight

Month	*NB Freight Tons*	*SB Freight Tons*	*Total Freight*	*NB Freight %*	*SB Freight %*
Dec 2018	63052	47873	110925	56.8	43.2
Jan 2019	60151	52807	112959	53.3	46.7
Feb 2019	36834	46586	83420	44.2	55.8
Mar 2019	38786	43303	82089	47.2	52.8
Apr 2019	43211	58172	101383	42.6	57.4
May 2019	62585	91602	154187	40.6	59.4
Jun 2019	149121	146296	295417	50.5	49.5

Jul 2019	67865	85955	153821	44.1	55.9
Aug 2019	69608	76087	145695	47.8	52.2
Sep 2019	62651	77901	140552	44.6	55.4
Oct 2019	87243	106490	193733	45	55
Nov 2019	48816	63476	112291	43.5	56.5
TOTAL	**789924**	**896549**	**1686473**	**–**	**–**
AVERAGE	**65827**	**74712.4**	**140539.4**	**46.7**	**53.3**